Acta Mineralogica-Petrographica, Szeged, XXXIX, 21–34, 1998

MINERALOGICAL-PETROLOGICAL STUDY ON ORE VEIN PENETRATED BY THE KEY-BOREHOLE BAKSA NO. 2 SE TRANSDANUBIA, HUNGARY

T. TARNAI[1]

Department of Mineralogy, Geochemistry and Petrology
Attila József University, Szeged, Hungary

ABSTRACT

In 1995/96 complex study on ore minerals occurring in a 7 cm thick vein traversed in the drilling Baksa 2 at 186.4 m depth was made in the Department of Mineralogy, Geochemistry and Petrology of the Attila József University (Szeged, Hungary) to determine their mineralogical and genetic features. In this paper, results of ore microscopic study and those of the inclusion analyses are published.

The ore vein is massive sulphide one (almost its 60 % is composed by sulphide ore). Two phases can be distinguished in the vein by both ore microscopy and inclusion analysis. The outer ore phase is quantitatively subordinate. Its mineral paragenesis: chalcopyrite, galena, sphalerite, pyrite (marcasite). The inner ore phase represents the main mass of the vein; its minerals: pyrite (marcasite), sphalerite, chalcopyrite, pyrrhotite. Pyrite (marcasite) and sphalerite are the quantitatively most dominant minerals. The dominant non-ore minerals are quartz and carbonate minerals.

Possibly, the vein was formed in closed system at low pressure in a temperature interval ranging from 250 to 310 C°. A two-phase formation can be supposed. It is most likely that fluids forming the ore vein are differentiates of a real magmatic melt. Identification of the regional connection is quite difficult, however, it can be brought into connection with either the Permian volcanism in the Villány Mountains or an unknown independent volcanic activity.

INTRODUCTION

Aim of the key borehole Baksa 2 deepened in 1978/79 was to reveal crystalline rocks of Baksa Complex. Hydrothermal ore indications were found in several places in the rock beds traversed in great thickness. The most important of them was the 7 cm thick massive sulphide ore vein traversed at a depth of 186.4 m (*Fig. 1*).

Preliminary studies of the ore minerals found in the key borehole Baksa 2 were performed by SZEDERKÉNYI T. (1979) and GRASSELLY GY. (1979) in the József Attila University in Szeged. A detailed ore economic geological study on the formation traversed by the borehole was accomplished in 1996 (TARNAI T., 1996).

In this paper, results of the ore microscopic and inclusion studies on the vein traversed at a depth of 186.4 m are published by data that have not been published yet. Since geological setting of the exposed formations and formations traversed by the borehole was reviewed in a previous paper (TARNAI T., 1997), only the direct neighbourhood and host rocks of the ore vein will be characterised in this publication.

[1]H-6701 Szeged, P.O.Box 651, Hungary

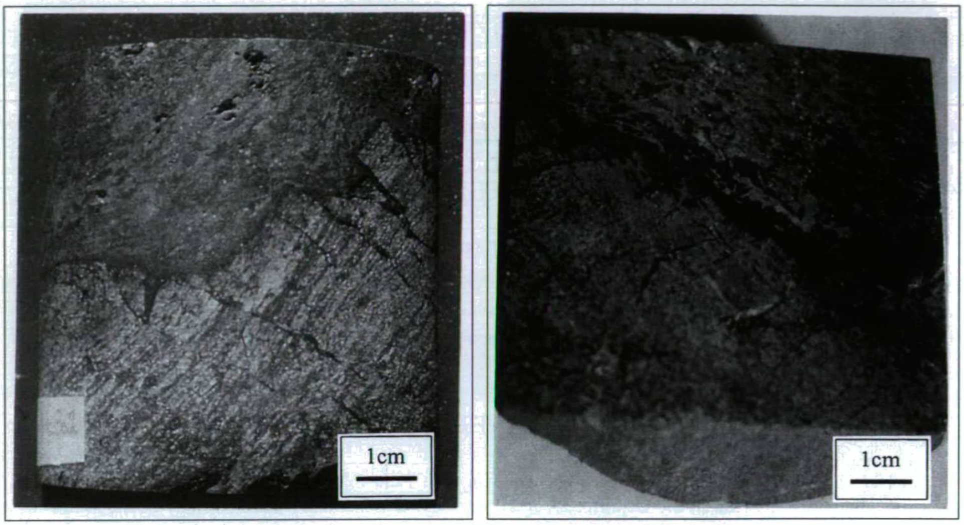

Fig. 1. Key borehole Baksa 2. Core sample of the ore vein traversed at 186.4 m depth (convex side and polished slab of the core)

CHARACTERISATION OF THE ORE VEIN FROM A DEPTH OF 186.4 M AND ITS ENCLOSING ROCK

The vein can be found in the Upper Márványos Member (57.1-223.7 m) and in the two-mica schist 'bed' occurring from 178.9 to 187.6 m. Its direct enclosing rock is chloritic gneiss (SZEDERKÉNYI T., 1979). Metamorphic schistosity of the enclosing rock can well be seen. Its polished sections excellently show that the intruded hydrothermal products well permeated and highly impregnated the enclosing rock along veinlets and apophyses. These veins have quite dark, almost totally black colour. In the host rock, glittering ore minerals, which crystalised along the thin veins, can be observed even 4 cm from the contact of the vein. Contact of the vein and the enclosed rock is sharp and outlined. The chloritic gneiss broke and cracked in a zone of some cm (*Fig. 2*).

The hydrothermal veins are 7 cm thick. In its neighbourhood, there are more smaller veins of some mm (or at most one cm) thick parallel to it. The ore vein is massive sulphide, non-ore minerals occasionally occur in it, only. Size and frequency of free spaces and gapes increase toward the centre. They are not filled by secondary material. Except of some rare crystals, the ore minerals are absolutely xenomorphic, and they are strongly interfingered. It can be seen that formation of the ores is striped, and their orientation is more or less parallel to running and sides of the vein. Bordering the vein and fitting to the side, a dark, almost black (similar to the veinlets in the enclosing rock), varying wide (1-4 mm) phase with the same orientation can be observed both in the polished and unpolished surface of the sample. It seems to be independent. Sulphides of the vein seem to be fresh, disregarding the superficial oxidation cover resulted by two decades storing in the open air. Pyrite can easily identified by eyes just as well as the glittering galena in the polished samples, however sphalerite can only be supposed. By single microscope, greenish golden yellow chalcopyrite and sphalerite (together with its inclusions) as disseminated grains can also be seen in the black zone fitting to the vein (*Fig. 1* and *2*).

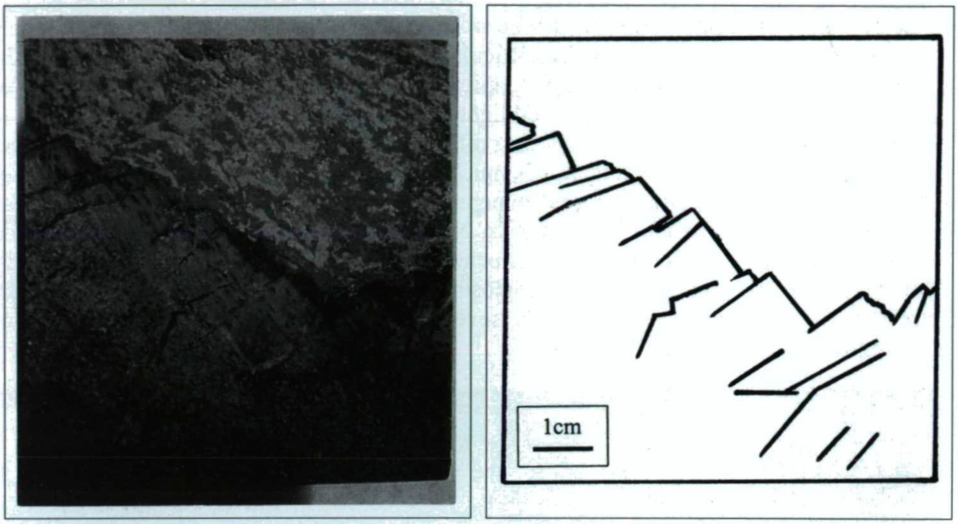

Fig. 2. Key borehole Baksa 2. Polished slab and main fracture lines of the core sample of the ore vein traversed at 186.4 m depth

ANALYSES

1. MICROSCOPIC STUDIES

A NIKON MICROPHOT-FXA polarizing microscope was used for the microscopic studies. Ore and non-ore minerals were identified in polished slabs and thin sections, respectively. Preparations for analyses were made by the usual way.

1.1. STUDIES IN REFLECTED LIGHT

The following minerals were identified in the course of study on the ore phase: pyrite, sphalerite, marcasite, pyrrhotite, chalcopyrite, galena. There was no other ore mineral that can be identified by a light microscope. Of the non-ore minerals, quartz can be determined on the basis of its idiomorphic shape, and presence of carbonate minerals can be supposed because of their high pseudoadsorption.

The ore veins are not homogeneous, there are two definitely separated parts having quite different ore mineral paragenesis. Hence, outer and inner (main) ore phases are distinguished. At the same time, however, there is no consistent difference between non-ore minerals occurring in the two phases. On the basis of the study on the polished slabs, therefore, it can not surely be determined wether two successive stages of the vein formation or a simple differentiated ore formation happened.

1.1.1. ANALYSIS OF THE OUTER ORE PHASE

Ore mineral paragenesis of the outer phase is the following: chalcopyrite, galena, sphalerite, pyrite (marcasite). Characteristic picture of the outer phase is shown by *Fig. 3.* As it has been mentioned in the macroscopic description, there is 1-4 mm wide black zone at the border of the vein and the enclosing rock, which is separated from the quantitatively more dominant main phase. It is more difficult to mark a border between the outer and the inner phase microscopically than macroscopically because the black colour visible by eyes can not been noticed. Studies in reflected light demonstrate the matrix of the two phases to be the same formation. It is an eye-striking difference, however, that, contrary to the inner ore phase, quantity of the ore minerals is much more subordinated comparing with that of the non-ore minerals, and the ore minerals occur as big independent crystals or disseminated grains or groups in the matrix. Non-ore material of the outer phase intruded into the cracks of the enclosing rock, and penetrated and impregnated it along apophyses. Although, sulphide content of the enclosing rock is generally more subordinated, somewhere – in some cases as far as several cm from the vein – ore minerals of considerable size were also crystalised.

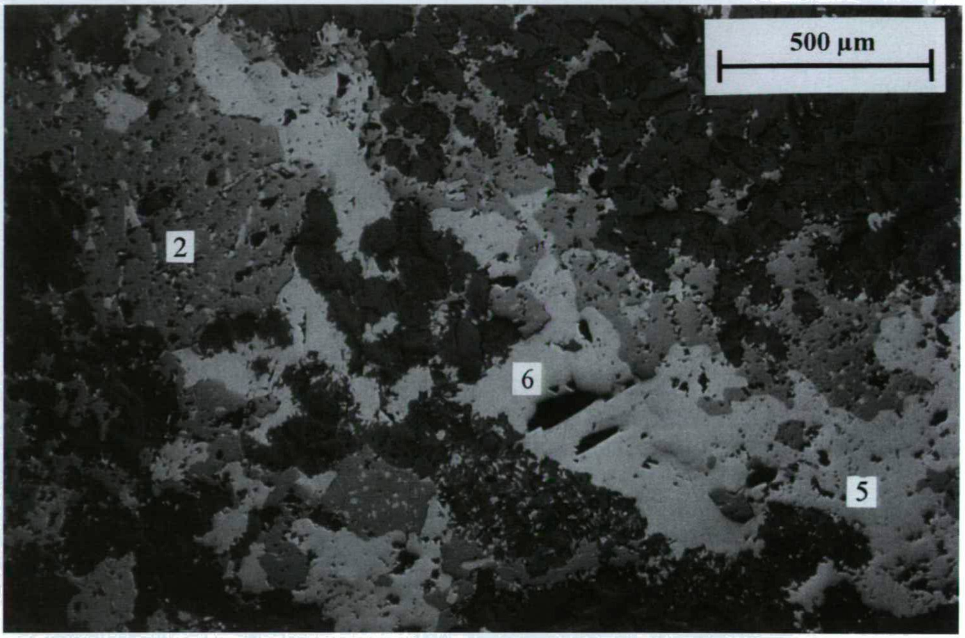

Fig. 3. Key borehole Baksa 2. Characteristic textural pattern of the outer ore phase of the ore vein traversed at 186.4 m depth. (Reflected light, 40x, 1 N). Legend: 2. sphalerite; 5. chalcopyrite; 6. galena

Chalcopyrite can be found as independent crystals in this phase, only; it occurs only as inclusions of sphalerite in the inner phase. It mainly appears as disseminated grains or bigger independent crystals. It is mainly accompanied by sphalerite, galena and pyrite. They can be intergrown, and can also occur as inclusions of each other. It frequently contains non-ore minerals, pores and gaps. Its quantity is quite small regarding the whole vein, however, it is significant in the outer ore phase; of the sulphide minerals it has the highest quantity in this phase. It is xenomorphic, its colour is the usual slightly greenish yellow. Size of its crystals is varying, therefore, it is not characteristic. The biggest crystal what I saw was 2.4 mm long.

As chalcopyrite, ***galena*** also occurs in the outer phase, only. It also has xenomorphic appearance, and, similar to chalcopyrite, it occurs as disseminated grains or bigger independent crystals. It is accompanied by minerals of the paragenesis in varied forms, and, similar to them, it has variable size. It can be found at the border of the inner main and the outer phases as well as along a veinlet in the enclosing rock 6 cm from the vein. The characteristic arrow-head-like 'cracklings' coming from cleavage can be observed very well. Length of the biggest studied crystal was almost 2 mm. Quantity of galena is also subordinated, it is half or two-thirds of that of chalcopyrite.

Galena was not mentioned by GRASSELLY GY. (in SZEDERKÉNYI T., 1979) in his ore optic study on the sample ÁGK-362. Galena occurs in the margins of the vein (i.e., in the outer phase), and it is probable that the sample studied by him was cut from the centre part of the vein where, as I mentioned, this mineral does not occur. It is characteristic, however, that galena is frequent in apophyses and veinlets intruding into the enclosing rock. For example, there is galena crystal of 1 mm intergrown with chalcopyrite 6cm from the ore vein in quartziferous groundmass.

Pyrite crystals in the outer phase are paler yellow, much smaller and more subordinated than in the inner phase. Studying them by two nicols, they also have paler colour. In some cases they are idiomorphic appearance (triangular and quadratic shape). On the basis of a cut, wideness of a face of a hexahedron was 0.25 mm. Pyrite occurs as independent crystals, inclusion in sphalerite and chalcopyrite, and intergrowing with sphalerite, chalcopyrite and galena. It size is variable, but it is smaller than the above mentioned three minerals. Its quantity is much lower than that of galena, sphalerite and chalcopyrite. The pyrite crystals are strongly marcasitized, fresh ones occur besides the idiomorphic crystals, only.

Sphalerite of the outer phase has similar features to that of the inner phase; therefore, it is characterised in details in that chapter. The difference between them is that size of crystals and inclusions found in them is smaller (size of inclusions in the outer phase 1 μm or hardly bigger). Moreover, sphalerite in the outer phase contains only chalcopyrite inclusions (but it does not contain pyrrhotite inclusions), and occurs as independent crystals or together with galena and chalcopyrite. The sharp differences between the two ore phases in the cases of the other three minerals (pyrite, chalcopyrite, galena) can not be observed for sphalerite. Feature of sphalerite crystal gradually changes from the border to the centre of the vein: size of its inclusions and quantity of its pyrrhotite inclusion increases.

1.1.2. ANALYSIS OF THE INNER ORE PHASE

Its ore mineral paragenesis is the following: pyrite (marcasite), sphalerite (with chalcopyrite and pyrrhotite inclusions), pyrrhotite. It is massive sulphide. It is mainly composed by pyrite, sphalerite and non-ore minerals. Pyrite has pyrrhotite inclusions, and it is marcasitized in several places. Sphalerite frequently has pyrrhotite and chalcopyrite inclusions. The characteristic formation of inner (main) ore phase is shown by *Fig. 4*.

Microscopic studies support the macroscopic description on its texture. Although, orientation parallel with the wall of the vein and zonality is less visible on a microscopic scale, however, it can be observed everywhere, and is quite characteristic in some cases. Its texture can hardly be characterised by the general terminological terms. Its texture is dominated by pyrite, sphalerite and non-ore minerals. The mineral grains are intergrown, or they displace each other, but there are absolutely linear contact borders, too. Ore minerals can occur as inclusions, fine dissemination or small flakes in non-ore minerals, and vice versa, ore grains also contain inclusions of non-ore minerals. Presence of pores and bigger continuous gaps also belongs to the complex textural pattern.

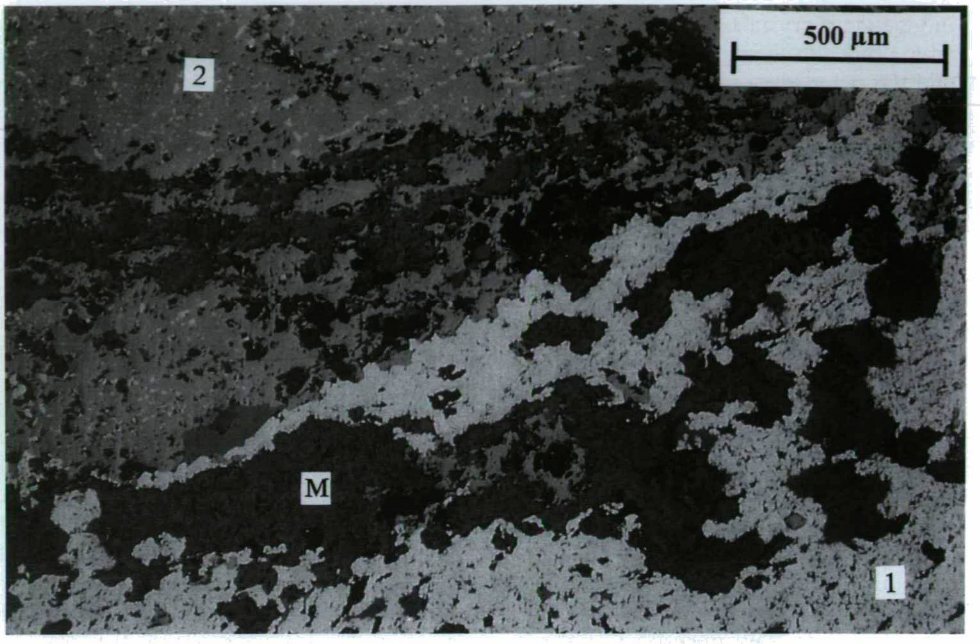

Fig. 4. Key borehole Baksa 2. Characteristic textural pattern with zonal formation of the inner (main) ore phase of the ore vein traversed at 186.4 m depth. (Reflected light, 40x, 1 N.)
Legend: 1. pyrite (marcasitized); 2. sphalerite; M: non-ore material

It seems to be a regularity that relative quantity of the pore space increases toward the centre of the vein, while that of sphalerite decreases. Change in quantity of pyrite and non-ore minerals does not show this kind of characteristics.

Non-ore minerals have no forms in most cases, however, quartz grains are frequently hypidiomorphic, and sometimes idiomorphic. Probably, quartz played a role in the vein formation as the first crystallisation product. Beside quartz, carbonate minerals can be identified by their characteristic pseudoadsorption under ore microscope.

Ore minerals are absolutely allotriomorphic (xenomorphic), and they are intergrown at their borders in most case. Independent crystals can hardly be found, they are arranged as complex groups or irregular net according to the manner mentioned in the textural description.

Pyrite (marcasite) is the most important mineral of the main phase. Its quantity (together with marcasite) reaches almost the one-third part of the ore vein. It is always xenomorphic; isometric faces can very rarely be found at its border to the pores, only. It is very slightly anisotropic at crossed nicols. This brownish-blueish anisotropy is hardly visible even in the freshest part of the crystals. The most characteristic feature is that it appears as tabular crystals of 1-2 or 5 mm and inclusions of some 10µm in other minerals. Absolutely fresh samples having intact border, and crumble, resorbed and slightly weathered parts also occur. Many fissures cutting up the vein are secondarily filled by pyrite. These fissures are younger than the vein, and they cut through both the inner phase and the enclosing rock.

Marcasitisation of pyrite is a quite characteristic process. All in all, it can be stated that weathered or partly weathered pyrite gives almost the half part of the vein. Marcasitisation is easily identified by crossed nicols. However, separation of the marcasitized area from the fresh part is difficult. Therefore, pyrite and marcasite can not absolutely be separated from each other. This is the reason why these two minerals are not separated from each other in the identification of mineral composition.

Pyrite has many groundmass inclusions and unfilled pores, very few and sporadic sphalerite and about 1% pyrrhotite inclusions. Presence of pyrrhotite inclusions are the most characteristic for them. This will be discussed in details later.

Sphalerite is the other main mineral in the ore vein. Its quantity is similar to that of pyrite: it gives about 25 % of the ore vein. Its position in the ore vein and its role in the determination of the textural character is the same what was mentioned above and written in the case of pyrite. Its size is similar to that of pyrite, borders of its grains are just like those of pyrite, however, sphalerite is always xenomorphic. It has no isometric face even at its side at the pores. Sphalerite appears at first in the interface of the inner and the outer phase; pyrite can hardly be found in this zone. It seems that sphalerite would have crystalised first during formation of the zonal arrangement. (Apart from this, every feature of this part of the zone, such as habit of sphalerite, is just like that of the main phase, therefore, it was not separated as a third phase.)

It is very characteristic that sphalerite is extraordinarily rich in **chalcopyrite** and **pyrrhotite inclusions** (2.2 and 1.3 %, respectively). These inclusions appear as oriented drops, lamellas, sometime spindles, or non-oriented drops and lamellas. Sphalerite of the outer phase contains only chalcopyrite inclusions which are much smaller than those of sphalerite in the inner phase. However, sphalerite in the main phase contains both chalcopyrite and pyrrhotite inclusions. It also contains non-ore material, pore and pyrite inclusions in subordinated quantity. In the cases of the oriented inclusions, chalcopyrite and pyrrhotite drops, lamellas, spindles alternate with each other many times even within the members situated in a line. There are inclusions, mainly among the smaller ones, which are composed of both minerals. Two fractions (a smaller and a bigger) of the inclusions can be distinguished. It is probable that the former is a product of intergrowth, while the later is that of exsolution. The bigger are 50-150 μm, and pyrrhotite is more frequent among them. Size of the smaller ones ranges from the smallest size to 10-15 μm, and chalcopyrite is more frequent among them. The bigger pyrrhotite inclusions are quite similar to which occur in pyrite, however, these are bigger by an order, and never weathered. Appearance and composition of the inclusions may also suggest that the vein was formed at high temperature. Temperature of the fluid must at least be supposed so high that it made formation of proper mixture of copper, iron, zinc and sulphur possible. Then sphalerite crystalised together with chalcopyrite and pyrrhotite mainly in the form of oriented intergrowth. Presumably, pyrite enclosing pyrrhotite crystalised in the same stage, which is suggested by intergrowth of pyrite and sphalerite. Sphalerite still had high iron an copper content. For this reason, another, although much smaller, inclusion association unmixed from sphalerite as exsolution inclusions.

Beside its appearance characterised at sphalerite, **pyrrhotite** can be found in pyrite as inclusion in a quantity of 1.3 %. Its size is quite variable, it ranges from some μm to almost 1 mm. Pyrite always surrounds it together with non-ore minerals and pores at the border, in this way this kind of pyrrhotite never contacts other ore minerals. Fresh, slightly and totally altered (which can be identified by its alteration product) pyrrhotite occurs, too. Consequently, the pyrrhotite-pyrite contact border is quite variable: there are both linear contact formed by identifiable crystal faces and altered pattern displacing pyrrhotite. Its main alteration product is marcasite, subordinately pyrite. Marcasitisation of pyrrhotite has an effect on pyrite surrounding it, because this pyrite also suffers this alteration.

1.1.3. IDENTIFICATION OF THE MINERAL COMPOSITION

The mineral composition was also identified by reflected light. Only the main phase was analysed. Area of the outer phase was not analysed either together with or separately from the main phase since it has only diagnostic importance because of its small quantity. Consequently, the following results do not concern the outer phase. Three big sections of the ore vein were used for identification. These preparations (sections 1, 2 and 3) were made from the whole halved core.

First, percentage of pyrite, sphalerite, pyrrhotite, non-ore minerals and pores was determined (Table 1). Marcasite and pyrite is summed up because they can not quantitatively be distinguished. Magnified forty times and a grid of 400 was applied for the analysis. In the second step, percentage of chalcopyrite and pyrrhotite inclusions in sphalerite was determined by a grid of 400 at a magnified 400 times (Table 2). Finally, the real modal composition was calculated by a comparison of the results of these measurements, i.e., inclusions of sphalerite were considered (Table 3).

TABLE 1

Key borehole Baksa 2. Mineral composition of the 7 cm thick massive sulphide vein found at 186.4 m depth (Inclusions of sphalerite are left out of consideration.)

Percentage modal composition of the inner (main) phase of the ore vein (inclusions of sphalerite are left out of consideration)						
Fraction or mineral	*section 1 mean*	*section 2 mean*	*section 3 mean*		*'gross mean'*	*'net mean'*
Pore	6.59	2.12	4.28		4.33	-
Non-ore minerals	39.98	39.14	37.99		39.05	40.81
Pyrite (marcasite)	29.39	34.35	30.61		31.46	32.88
Sphalerite	23.70	24.04	26.90		24.86	25.99
Pyrrhotite	0.34	0.36	0.22		0.31	0.32
Total	100.00	100.01	100.00		100.01	100.00

TABLE 2

Key borehole Baksa 2. Inclusions of sphalerite in the 7 cm thick massive sulphide vein found at 186.4 m depth.

Percentage modal composition of sphalerite found in the inner (main) ore phase of the ore vein					
Fraction or Mineral	*section 1 mean*	*section 2 mean*	*section 3 Mean*		*Mean*
Sphalerite	96.08	96.87	96.48		96.45
Chalcopyrite	2.52	1.90	2.08		2.20
Pyrrhotite	1.40	1.22	1.44		1.36
Total	100.00	99.99	100.00		100.01

On the basis of the measurements, the total percentage of the sulphides is 56.5 % in the vein. Pyrite (marcasite) (31.5 %) and sphalerite (24 %) are the main components, and pyrrhotite (0.5 %) and chalcopyrite (0.5 %) are the accessory ore minerals. Besides non-ore minerals (39 %), gaps and pores can also be found in considerable quantity (4.5 %) in the vein. The 24 % of the sphalerite represents a remarkable Zn-accumulation in the vein.

TABLE 3

Key borehole Baksa 2. Mineral composition of the 7 cm thick massive sulphide ore vein found at 186.4 m depth (Inclusions of sphalerite are taking into consideration.)

Percentage modal composition of the inner (main) phase of the ore vein (Inclusions of sphalerite are taking into consideration)			
Fraction or mineral		*'gross mean'*	*'net mean'*
Pore		4.33	-
Non-ore minerals		39.05	40.81
Pyrite (marcasite)		31.46	32.88
Sphalerite		23.98	25.06
Pyrrhotite		0.65	0.67
Chalcopyrite		0.55	0.57
Total		100.02	99.99
Sulphide ore minerals		56.64	59.18

1.2. ANALYSES IN TRANSMITTED LIGHT

Ore minerals excepting sphalerite are opaque, therefore they can not be studied in transmitted light. In general, they xenomorphic, but there are some hypidiomorphic and idiomorphic grains, too (*Fig. 5*).

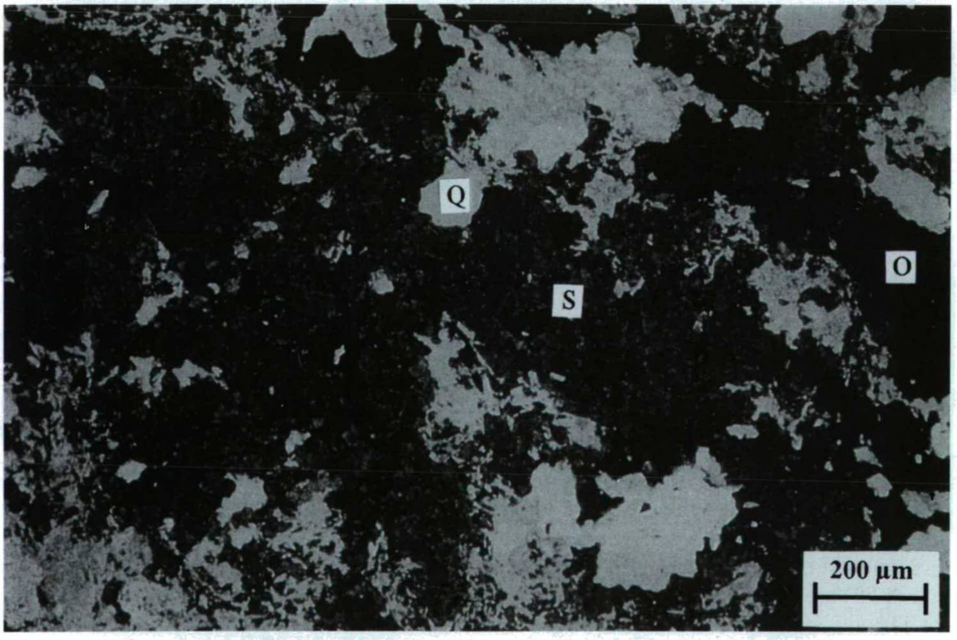

Fig. 5. Key borehole Baksa 2. Characteristic textural pattern of the inner (main) ore phase of the ore vein traversed at 186.4 m depth. (Transmitted light, 100x, +N)
Legend: O: opaque mineral; S: sphalerite; Q: quartz

Sphalerite is reddish brown and totally translucent at one nicol. Polysynthetic twins and chalcopyrite and pyrite inclusions can well be seen. The bigger (50-150 μm) and the smaller (5-15 μm) chalcopyrite and pyrrhotite inclusions occur at the border of the twins and inside of sphalerite, respectively (see at the ore microscopic description). These inclusions have sharp border line, this way, they can easily be recognised. Probably, the bigger ones are product of epitaxy, while the smaller ones come from exsolution. Some kind of zonality of sphalerite can also be observed on the basis of the oriented inclusions. Thin section explains the phenomenon that the biggest pyrrhotite inclusions are always inside of the sphalerite, which seems to be homogeneous on the polished slabs. Borders of sphalerite can be seen on thin sections, and it can be observed that big pyrrhotite inclusions fill the gaps between contacts of more sphalerite crystals. Sphalerite shows moderate anisotropy at crossed nicols, i.e., birefractive. This property is quite interesting because it belongs to the isometric system. The interference colour is dwarfed by its own colour.

Non-ore minerals were not studied in details, only the two most important components, quartz and calcite(carbonate), are described.

Quartz is the dominant non-ore mineral (at least 50-70 % of the non-ore material). Most of them occur as xenomorphic crystals of hexagonal section. The mean size is 2-400 μm. On the basis of some section parallel to the axis c, it can be stated that the characteristic width:length ratio is approximately 1:3-1:4, and there are pyramids on both ends of the crystals. Subordinately, hypidiomorphic and xenomorphic crystals also occur.

Quantity of ***calcite*** is also considerable. It occurs as xenomorphic crystals, only. It mainly fills the residual space, however, in some cases it covers opaque minerals and quartz as a thin layer. This suggests that it was formed in later crystallisation phase than quartz. Calcite represents approximately 10-20 % of non-ore minerals of the sample.

2. INCLUSION ANALYSES

Analysis of fluid inclusions in quartz grains of the vein was used for determination of thermal and pressure conditions during formation of the sulphide ore vein in the key borehole Baksa 2 at 186.4 m depth. It was eye-striking even microscopically that there are many fluid inclusions in the quartz grains found between the ore minerals. Both one-phase (fluid or gas) and two-phase (fluid + gas) inclusions occur. ZEISS JENA AMPLIVAL polarizing microscope equipped with CHAIXMECA heat-stage was used. The range of the equipment is from -180 C° to +600 C°, its accuracy is +/- 0.2 and 0.1 C° at homogenization (400 C°) and freezing, respectively (GATTER I., 1983). The results are listed in Table 4.

First, two-phase (gas + fluid) inclusions were analysed. Fluids in the inclusions were frozen by liquid nitrogen, and then heated at room-temperature; meanwhile, the initial (Te) and the final or total (T2) melting signs as well as temperatures belonging to them were detected. When the inclusions were heated to high temperature, homogenization temperature was observed. Results of the analyses and the values corrected because of instrumental constant are listed in table 4. Salinity values calculated from the final melting point (T2) are also shown by Table 4.

The second step was analysis of gas inclusions in which CO_2-phase could be detected in the form of non-mixing fluid phases at room-temperature (Table 5). Frequency of the inclusions containing CO_2 is subordinated in the ore vein.

TABLE 4

*Key borehole Baksa 2. Results of the inclusion analyses. *NaCl equivalent weight % (Calculation was by Flincor program.)*

Number of the inclusion	Measured Te (C°)	Calculat. Te (C°)	Measured T2 (C°)	Calculat. T2 (C°)	Calculat. Salinity*	Measured Th (C°)	Calculat. Th (C°)
1.	-47	-48	-2.6	-3.1	5.09 %	295	284.3
2.	-47	-48	-2.6	-3.1	5.09 %	295	284.3
3.	-47	-48	-2.4	-2.9	4.79 %	291	280.7
4.	-47	-48	-2.4	-2.9	4.79 %	291	280.7
5.	-47	-48	-2.2	-2.7	4.48 %	286	276.1
6.			-2.2	-2.7	4.48 %	286	276.1
7.	-47	-48	-2.1	-2.8	4.32 %	278	268.7
8.			-2.1	-2.8	4.32 %	278	268.7
9.			-1.6	-2.1	3.53 %	272	261.4
10.	-45	-46	-2.8	-3.3	5.04 %	265	256.8
11.	-47	-48	-2.1	-2.6	4.22 %	245	238.2
12.			-2.2	-2.7	4.48 %	245	238.2
13.	-45	-46	-2.4	-2.9	4.79 %	240	233.5
14.			-1.6	-2.1	3.53 %	235	228.3

TABLE 5

Key borehole Baksa 2. Results of preliminary analyses of the inclusions containing CO_2. Ratio of H_2O and CO_2 was calculated by Flincor program.

Number of the inclusion	H_2O content of the inclusion (mol %)	CO_2 content of the inclusion (mol %)	Homogenization temperature of the CO_2
1.	38.8 %	61.2 %	-21.0 °C
2.	40.3 %	59.7 %	-19.5 °C
3.	64.2 %	35.8 %	-13.2 °C
4.	36.1 %	63.9 %	-23.6 °C
5.	40.4 %	59.6 %	-19.4 °C

A T/P diagram based on isochrons calculated from the measurement data by the Flincor program is shown by *Fig. 6.* A Th-salinity diagram was also compiled (*Fig. 7*).

CONCLUSIONS

The most important hydrothermal activity explored by the key borehole Baksa 2 is a 6-7 cm thick sulphide vein found at 186.4 m depth. Its ore paragenesis is the following: pyrite (FeS_2), marcasite (FeS_2), sphalerite (ZnS), pyrrhotite (FeS), chalcopyrite ($CuFeS_2$), galena (PbS). Conditions of the formation of the ore vein (band) were approximately reconstructed by ore optical and preliminary fluid inclusion analyses. On the basis of these studies, the vein was formed in closed system but at not too high pressure (150-300 bar) which does not mean too thick covering layer (60-120 or, at most, some hundreds m). Salinity of the fluid forming the vein is 4-5 % (in term of NaCl equivalent weight percent),

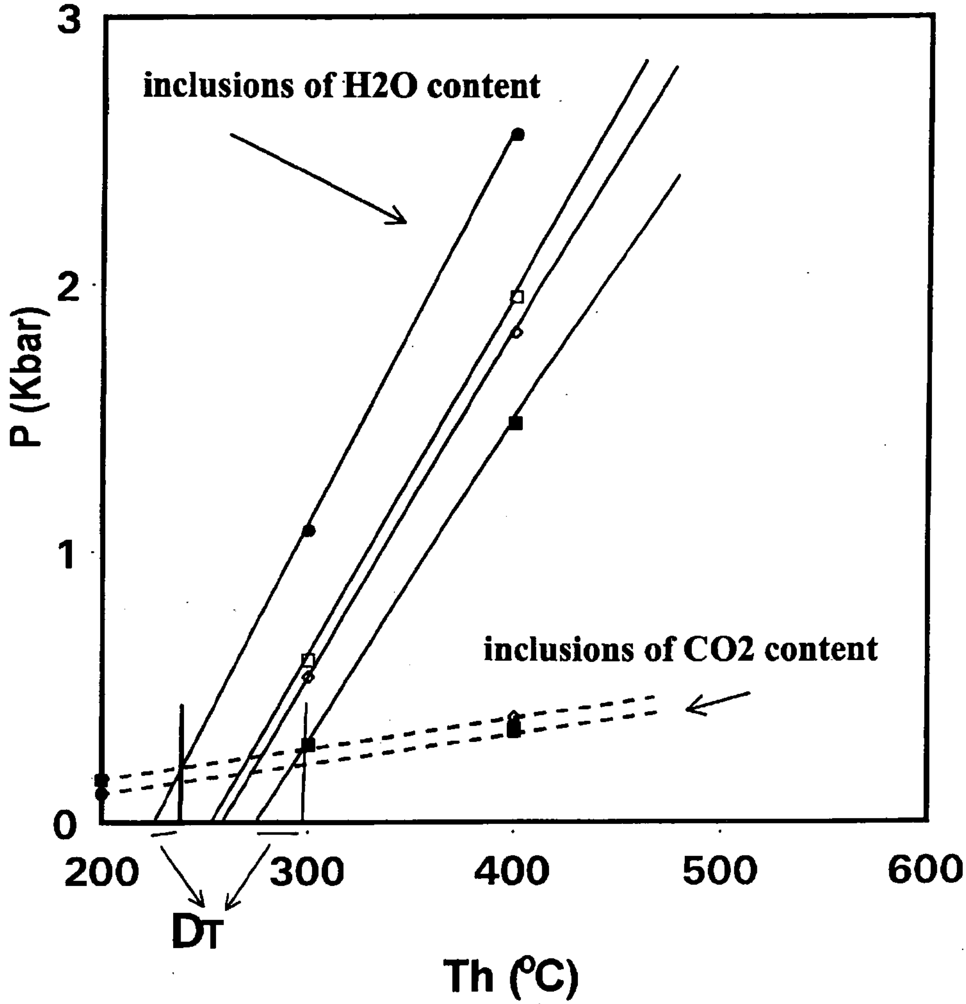

Fig. 6. Key borehole Baksa 2. Ore vein traversed at 186.4 m depth. T/P diagram based on the inclusion analyses and isochrons calculated by the Flincor program.

which is moderate, and suggests that considerable meteoritic water was not added to the ascending solutions. Both inclusion and ore microscopical analyses suggest that two phases can be distinguished in the formation of the vein. Paragenesis of the first one is galena, sphalerite, pyrite (marcasite), and it was formed at lower temperature (250-270 C°). This outer phase can be found at the margins of the vein in a thickness of 3-4 mm, and in apophyses and veinlets along the vein. Ore paragenesis of the main or inner phase is pyrite, marcasite, sphalerite, pyrrhotite, chalcopyrite. It was formed at a higher temperature (290-310 C°). The ore vein is a massive sulphide one with an ore content of almost 60 %. It is a genetic matter, however, whether there are two successive phases of the vein formation or it is one ore mineral formation differentiated by temperature from each other.

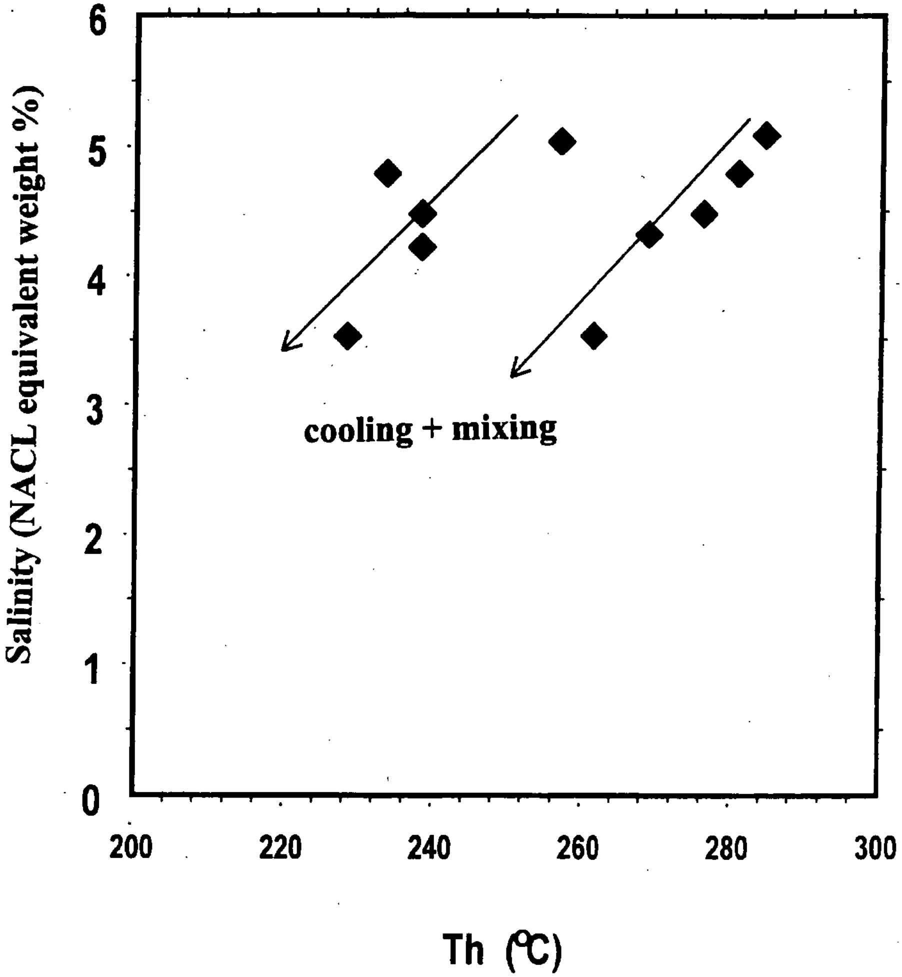

Fig. 7. Key borehole Baksa 2. Ore vein traversed at 186.4 m depth. Th-salinity diagram based on inclusion analyses.

Besides the values measured by fluid inclusion analyses, regular appearance of pyrrhotite and chalcopyrite and their exsolution in the inclusions also suggest a relative high temperature of the fluids forming the ore mineralisation.

The ore mineral paragenesis, results of the inclusion analyses, presence and habit of the main non-ore minerals (quartz, calcite, feldspar), their association with the variable ore minerals of relative high concentration can be resulted by a magmatic process. The ore vein may be in connection with the rhyolitic volcanism found in the basement in foreground of the Villány Mountains (FAZEKAS V.-VINCZE J., 1991), however, it is also possible that the ore vein of the crystalline formations of the Baksa Complex explored by the borehole Baksa 2 was formed by an absolutely new volcanic activity which has never known up till now.

ACKNOWLEDGEMENT

I would like to thank DR. ISTVÁN GATTER for making the inclusion analyses and interpretation of the results. I also express my thanks to DR. TIBOR SZEDERKÉNYI and TIBOR ZELENKA for choosing this topic for me and following my work with attention.

REFERENCES

BALLA Z. (1981): Plate tectonics interpretation of the south transdanubian ultramafics. - Acta Mineral. Petrogr. Szeged 25/1, pp. 3-24.

BARABÁS A., JÁMBOR Á., SZÉNÁS GY. et al. (1964): A Mecsek és a Villányi-hegység geofizikai kutatásának eredményei. - MÁELGI Évk. 1.

FAZEKAS V., VINCZE J., (1991): Hidrotermás Ércindikációk a Villányi-hegység északi előtere mélyfúrásaiban. - Földtani Közlöny 91/1-4, pp. 23-56.

GATTER I. (1983): Folyadék-gáz zárvány vizsgálatok a nyugat-mátrai érces képződményekben. Doktori értekezés. ELTE, Ásványtani Tanszék, Budapest.

GRASSELY GY. (1979): in: A mecseki ópaleozoós-prekambriumi alapszelvények komplex földtani feldolgozása (SZEDERKÉNYI T). Kézirat. JATE, Ásványtani, Geokémiai és Kőzettani Tanszék, Szeged. pp. 113-124.

HAJDÚ L. (1987): A telkibányai ércesedés vizsgálata korszerű anyagvizsgálati módszerekkel. Szakdolgozat. ELTE, Ásványtani Tanszék, Budapest.

HARANGI SZ. & ÁRVÁNÉ SÓS E. (1993): A Mecsek hegység alsókréta vulkáni kőzetei I. Ásvány- és kőzettan. - Földtani Közlöny 93/2, pp. 129-165.

JANTSKY B. (1979): A mecseki gránitosodott kristályos alaphegység földtana. - MÁFI Évk. LX.

KOVÁCS S. et al. (1996): Report of IGCP project. No. 276. Athenes (In press)

RAVASZNÉ BARANYAI L. (1969): Eclogite from the Mecsek Mountains, Hungary. - Acta Geol. Acad. Sci.13, pp. 315-322.

SZEDERKÉNYI T. (1974): Paleozoic magmatism and tectogenesis in Southeast Transdanubia, Hungary. Acta Geol. Sci. Hung., 18, 3-4, 305-313,

SZEDERKÉNYI T. (1977): Geological evolution of South Transdanubia (Hungary) in Paleozoic time. - Acta Mineral. Petrogr. Szeged 23/1.

SZEDERKÉNYI T. (1979): A mecseki ópaleozoós-prekambriumi alapszelvények komplex földtani feldolgozása. Kézirat. JATE, Szeged.

SZEDERKÉNYI T. (1983): Origin of amphibolites and metavolcanics of crystalline complexes of South Transdanubia, Hungary. - Acta Geol. Acad. Sci. Hung. 26/1-2, pp. 103-136.

SZEDERKÉNYI T., ÁRKAI P., LELKESNÉ FELVÁRI GY. (1991): Crystalline groundfloor of the Great Hungarian Plain and South Transdanubia, Hungary. Serbian Acad. Sci. and Arts Acad. Conf. 4, pp. 261-273.

TARNAI T. (1996) A Baksa-2. sz. földtani alapfúrásban feltárt ércásványok ásványtani és genetikai jellemzőinek vizsgálata. – Diplomamunka. JATE Ásványtani, Geokémiai és Kőzettani Tanszék, Szeged.

TARNAI T. (1997) Ore minerals from the key section of the Baksa Complex (W. Baranya Hills, Hungary). Acta. Mineral. Petrogr. Szeged 38. Supplementum, pp. 119–133.

VÁRSZEGI K. (1978): Série cristalline de Görcsöny. In FÜLÖP J. (Ed.): Lexique stratigraphique international. Vol 1. Europe. Fasc. 9. Hongrie. (pp. 223-224). - Centre Nat. de la Rech. Sci.

VÖRÖS I. (1970): Ércmikroszkópiai határozó. Tankönyvkiadó, Budapest.

Manuscript received 21 September, 1998.